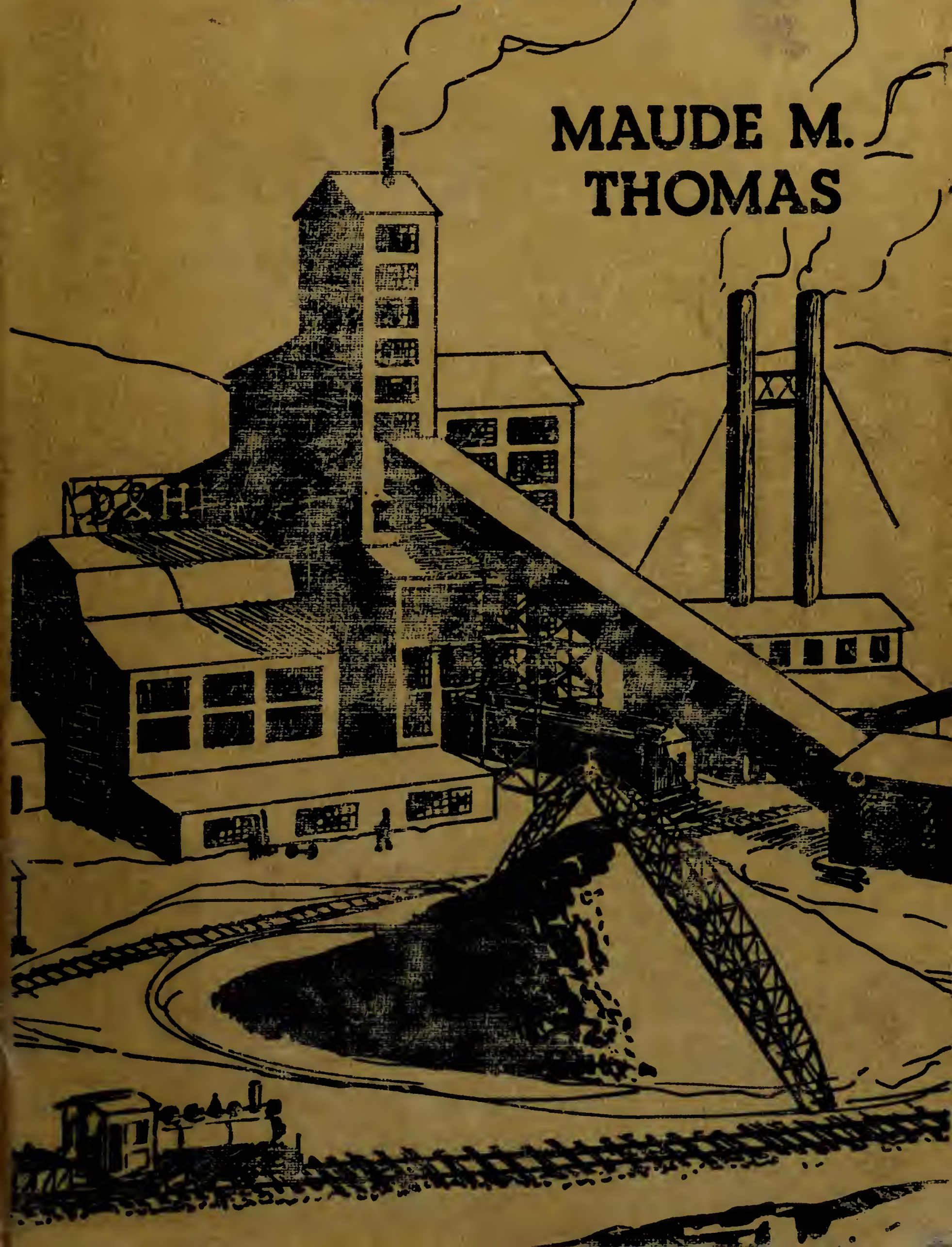
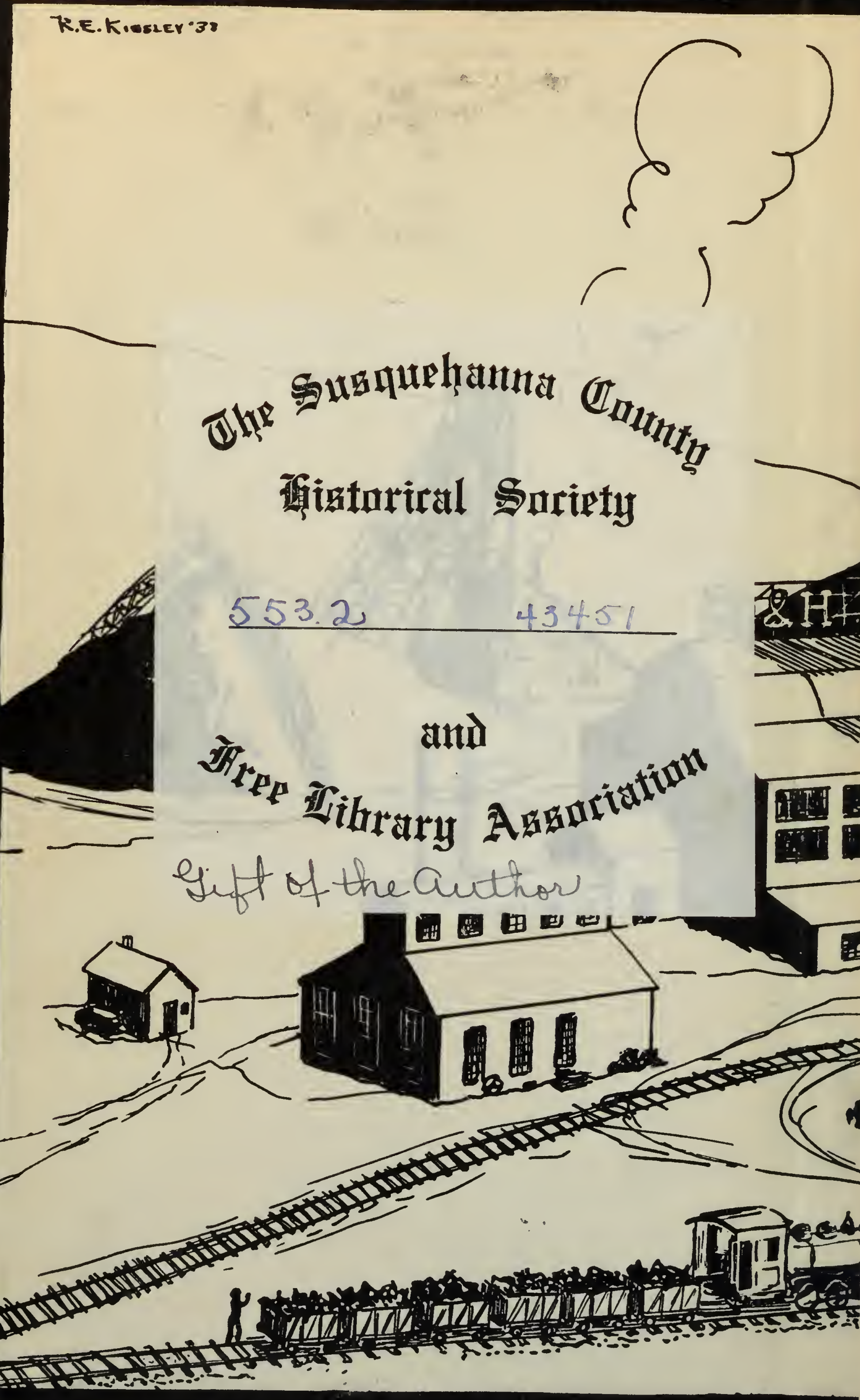
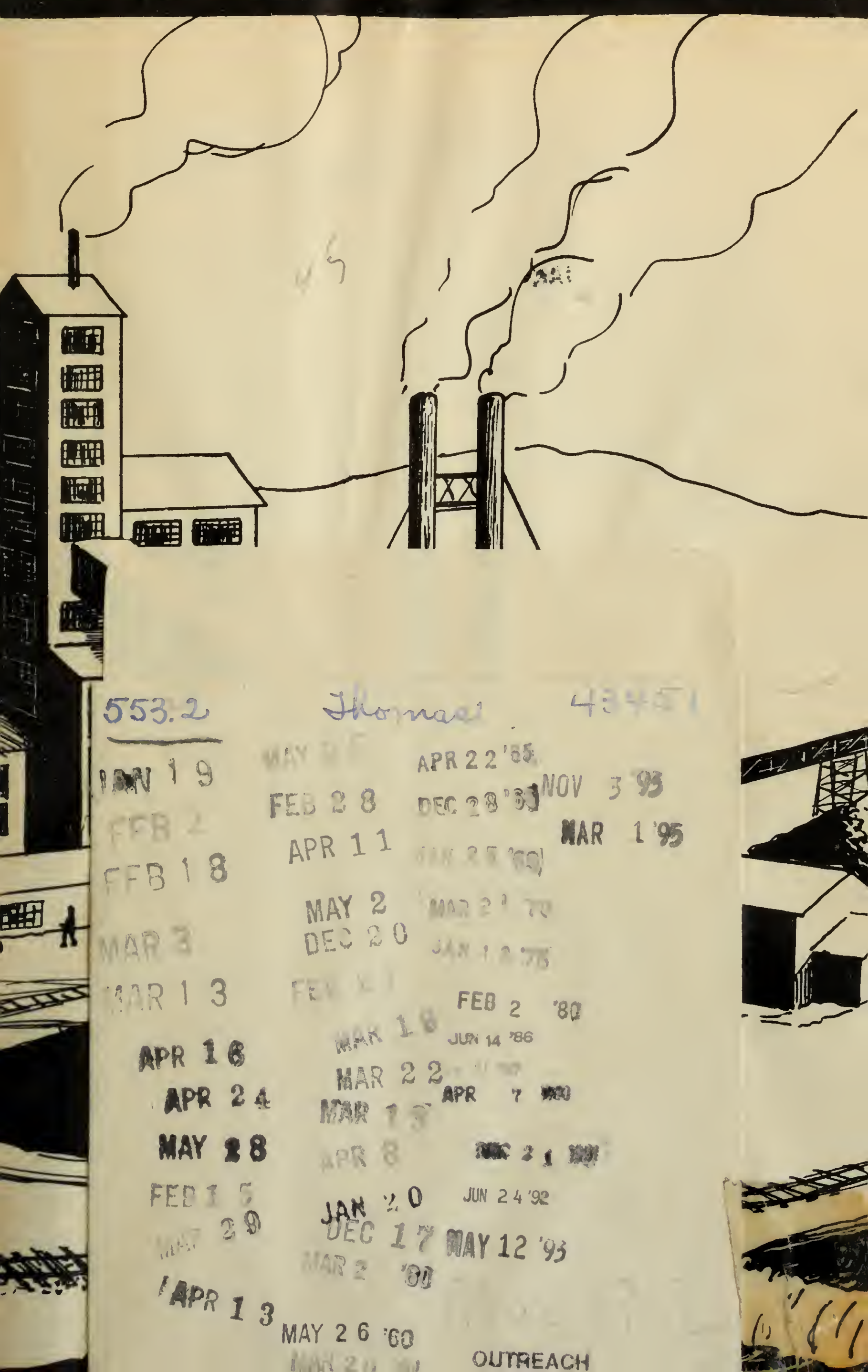
BLACK DIAMONDS

MAUDE M. THOMAS







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BLACK DIAMONDS

by

Maude M. Thomas

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CONTENTS

Chapter I

"BLACK BURN ROCKS"

IN NORTHEASTERN PENNSYLVANIA, within an area of 484 square miles of rugged, mountainous country, extend four irregular, canoe-shaped fields of anthracite, the world's richest fuel.

This section was once a forest-clad wilderness, bearing little evidence of the coal that underlay it. Indians and occasional white hunters clambered over its rocks and through its woods, and were puzzled to find that the rocks were in some places black and of a peculiar glossiness.

One of the hunters, leaving his fire burning one evening near these black rocks, went to sleep near-by. He was awakened later by a feeling of unexpected warmth at his feet, and was amazed to find that the black rocks were glowing in a beautiful symphony of color, of shimmering red and orange with pale blue flames dancing over the burning coals. The heat was intense.

He excitedly spread the word of the burning rocks. Other hunters found more of them. Indians, calling them "black burn rocks," brought bags of them to the white men for use in their blacksmith forges. Gradually, from this beginning in the 1760's, the world came to know of the tremendous richness of this wild land.

At first, though, the proper use of this amazing coal was not fully understood, and it took many years to educate the people to its true value. Men who believed in it and shipped it down the canals to Philadelphia were treated with scorn and suspicion by householders and manufacturers who would not believe that these hard black rocks could burn. This "stone coal," as it was called, had to be thrown away, and the shippers had to leave hurriedly to escape the wrath of those who felt they were being cheated.

The truth is that people had not yet learned to fire this hard coal. Accustomed to wood and soft coal, which light instantly, they did not realize that anthracite demands different methods of firing. However, Pennsylvania blacksmiths persevered in using it in their forges, learned to light and draft it properly, and were rewarded with the most intense fires they had ever kindled.

From the forges of these early blacksmiths anthracite emerged to take its high position in the industrial world. It gradually took the place of wood in the firing of steamboats and locomotives, and in 1835 began generating steam for the ferry boats crossing the Hudson River. Later it came into general use as a locomotive fuel.

Anthracite is also used in making water-gas, which is used for cooking, and is especially important in the smelting of iron, and in making steam for industrial uses.

In 1808, Judge Fell, a householder, constructed a grate for the use of anthracite in his home, found it successful, and by his example made possible the widespread use of anthracite in its highest form of service, that of providing practically smokeless, flameless, safe and steady heat to millions of homes and buildings.

Thus the industry began. This corner of Pennsylvania became populated with miners who knew how to mine anthracite, miners from the coal fields of Wales, for the most part, who knew that these surface rocks were but the outcropping of beds beneath the surface. They realized that these hills and valleys probably held great wealth.

Anthracite is also mined in Europe—in Germany, Wales, France and Russia, some parts of South America, and in Indo-China. Bituminous, or soft coal, is found in China and Japan, in Nova Scotia and Alberta, and in many states—Illinois and West Virginia, where the largest mines are found, Arkansas, Texas and Montana.

Since the year 1776, when anthracite was first shipped from Pennsylvania to be used in the manufacture of arms for Revolutionary soldiers, twelve billion dollars worth has been wrested from this region. The land is no longer a wilderness. Fine cities flourish in its valleys; Scranton, with its population of one hundred and fifty thousand, Wilkes-Barre, Hazelton, Shamokin, Pottsville, and countless towns and communities up and down the valleys.

The hills are no longer forest-clad, although still green and lovely. The valleys are scarred and torn, and new hills have arisen, hills of refuse taken with the coal from the mines. Having no fuel value, this refuse has been separated from the anthracite, and, because there is nothing else to do with it, it forms black, man-made mountains throughout the valleys.

Breakers and mine buildings are everywhere in these anthracite valleys. Even in the cities they rise in sur-

prising nearness to the stately beauty of public buildings and lovely homes. But they are not out of place. The Courthouse, the Library, the Masonic Temple, and other modern buildings and houses owe their existence to these blackened towers.

Chapter II

200 MILLION YEARS AGO

A COAL bed is sometimes called a vein, which is misleading. It is not really a vein; it is a bed, somewhat like a sagging blanket, or a saucer. A coal field is composed of many of these beds overlying each other and separated by thicker layers of rock. They lie in basins or valleys at a depth varying from a few feet beneath the surface to several hundred feet. The Northern Field of this Pennsylvania region covers an area about sixty-three miles long by four miles wide.

In some places there are twenty separate beds of coal lying one above the other. The solid coal varies in thickness from a few inches to fifty feet, which is the depth of the Mammoth bed in the Schuylkill Field, one of the very thick coal beds.

Even so, it is estimated that these vast deposits of anthracite are but five per cent of the original amount. Ninety-five per cent was washed away in ages past by

the movement of glaciers and the wearing down of the mountains.

These beds of anthracite are not flat, as are the soft coal or bituminous beds. They have been heaved by the movements of the earth into sharp curves and angles, which contribute to making the mining of anthracite the exciting industry it is.

In the early days of mining, men needed only to take off the surface coal, or to dig into upward sloping beds in an opening called a drift, which permitted under-ground water to drain off naturally, and the coal to be easily transported. They also dug slopes that would sometimes cut into several beds of coal, and which also allowed convenient transportation of coal to the surface.

As the supply of surface coal became exhausted, and as the industry grew in capital and in experience, shafts were sunk vertically through the layers of rock and coal, and gangways were sent out in as straight a line as possible from the shaft through the beds of coal. Thus the coal layers became honeycombed with miles of passageways and tracks, as the coal was blasted out and sent in carloads up the shaft to the surface.

Slopes are still driven into the beds, especially in the soft coal fields, but the shaft method is the usual form

of entering the mines in the hard coal field. Most collieries have both shaft and slope entries into a single mine, to comply with a law that insists that there be two exits to every mine, in case of accident.

A method known as stripping is also employed in mining coal. Steam shovels scrape off the overburden, or top soil, and expose the bed of coal, which is blasted and then lifted out by the steam shovel. This process is repeated for several layers, or until the expense of operation exceeds the value of the coal removed.

Anthracite itself is the king of the coal world, highest in the scale of coals. It had its origin in the same circumstance as did the other forms, peat, lignite, and the bituminous grades. But toward the end of its development the forces of nature set it apart from ordinary coal, and thrust it into its unique place in the world.

Two hundred million years ago this coal was once the living green of mammoth trees and tropical growth that flourished luxuriantly in the dense swamps of the land that is now Pennsylvania. The trees fell, and the leaves bogged down; waters closed in on them, rock and sand rolled over them, and then growth began again. For millions of years this growth and decay went on, and coal was gradually formed.

Then in this particular section of the coal world, a strange upheaval took place. The earth heaved and groaned and folded in on itself like a closing accordian. Mountains and valleys were formed, and the beds of soft coal were hardened and chemically changed by pressure and intense heat into pure anthracite. Like the diamond, anthracite is carbon, only diamonds are pure carbon in crystallized form. This is why hard coals are sometimes called "black diamonds."

Miners often find the imprints of ferns and leaves in the face of the coal they take out, and the fossilized trunks of tropical trees have often been unearthed. One of these, now in a museum, weighs nearly seven thousand pounds, and is composed of half coal and half slate.

Of the coals, peat, found at the bottom of swamps, is the least formed, and can be seen, as can the other phases of coal, in the process of formation in various parts of the world today. It is vegetation in the first stage of its decay, in which the form of the leaves and fibers can still be clearly seen. It is often used as a fuel, but is slow-burning and smoky.

As peat hardens it becomes lignite, a brownish, jelly-like mass that bears little resemblance to the vegetation

from which it was formed. It burns readily, but is low in heat value.

From lignite, coal changes gradually into the bituminous grades. These are gaseous, easily broken, and give off a long flame and black smoke when burned. Bituminous has many industrial uses, especially as a steam-producing fuel, and is readily turned into coke by heating to redness in ovens. It has high heat value.

Anthracite is to bituminous as the diamond is to glass. It is hard, black, and brittle. It is clean to the touch, even to the extent of allowing itself to be carved into decorative ornaments that may be handled without soiling the hands. It gleams and glistens and throws off glittering lights from its many surfaces. It burns with intense, lasting heat, and a smokeless blue flame.

Two miles from the heart of Scranton is a modern anthracite mine, one of the finest in the world. We are going to visit this mine, and go down under the ground to see the miners blast out the coal, one of the most dangerous occupations in the world. We are going to follow the coal on its eventful journey to the breaker, where it is treated to a variety of experiences, until it is finally run into railroad cars and trucks, completely subdued, and ready to perform its work in the world.

Chapter III

ON THE SURFACE

SIGN here, please," said the man behind the desk of the coal company's office as he passed a printed slip across the counter. "Mr. Reese will take you down into the mine."

Glancing over the slip, I was surprised to find the disconcerting words "accident," "injury," "death," "survivors." "In case of accident, I hereby absolve ——."

Seeing my uneasiness, Mr. Reese, the young mining engineer who was to be my guide, explained, "It's merely a formality, only to relieve the company of responsibility in case of an accident, which is really a rare occurrence, nothing to worry about at all. Actually, mines are run so well nowadays that one is really safer underground than on the surface."

I couldn't forget the disasters and wholesale mine deaths I had read about. I remembered stories of explosions and cave-ins, of floods and fires, of women and

children waiting in despair at the head of the shaft for news of their loved ones trapped below, of bodies brought to the surface, identified and mourned. I knew that some of the major disasters in history had occurred in coal mines.

But I signed the slip, as Mr. Reese continued, "You must remember that the disasters of the old days seldom happen now. They have practically gone with the past, for as the industry has developed, it has increased its safety devices, and at the price of sad experience and constant watchfulness has succeeded in making coal-mining the comparatively safe industry it is today. Such accidents as we suffer now are caused mostly by individual carelessness in riding the cars, in the use of dynamite, in faulty propping—but you'll see when we get underground."

He helped me into a blue denim coat as a protection against the black dust of the mine, handed me a waterproof cap, and himself put on a steel-like helmet. I wondered why his head needed more protection than mine.

"We call these 'hard-boiled hats,'" he smiled, patting the rippled crown and pulling on the visor. "They are made of pressed composition, which is as strong as steel. Steel would be dangerous, for if a steel hat on a

miner's head should come in contact with an over-head trolley in the mine, the miner would be electrocuted. They look rather lady-like, but these hats are one of the best protections a miner has. They have saved many a head from injury under a fall of roof. Miners protect their feet, too, from rock falls. They wear safety shoes, which have steel toe-caps and are built to resist tremendous pressure without denting. A 4500 pound steel truck can run over the toes of a man thus protected without causing injury."

I shivered slightly as we left the office, and felt as I'm sure a person must feel when he is about to be executed.

"Cold, isn't it?" I said, and Mr. Reese looked at me in surprise. The sun was shining brightly, and the world seemed full of people who were glad to be alive. But I had never been down in a coal mine before!

We walked slowly, for the shaft was near, and I wanted to see what the surface of a coal mine looked like. At first glance, the two hundred acres of surface property seemed to contain only three things: the shaft-head, the breaker, and the slate pile. These tower against the sky in black majesty. But presently I was aware that we were not alone. Jets of snow-white steam rose, and under this steam are buildings and pipes.

Large billows of it rise from the taller structures, little jets puff out unexpectedly from pipes along the ground.

The buildings are of brick, well-kept and sturdy, and constitute an investment of several million dollars. Mr. Reese pointed them out and explained what each one was for.

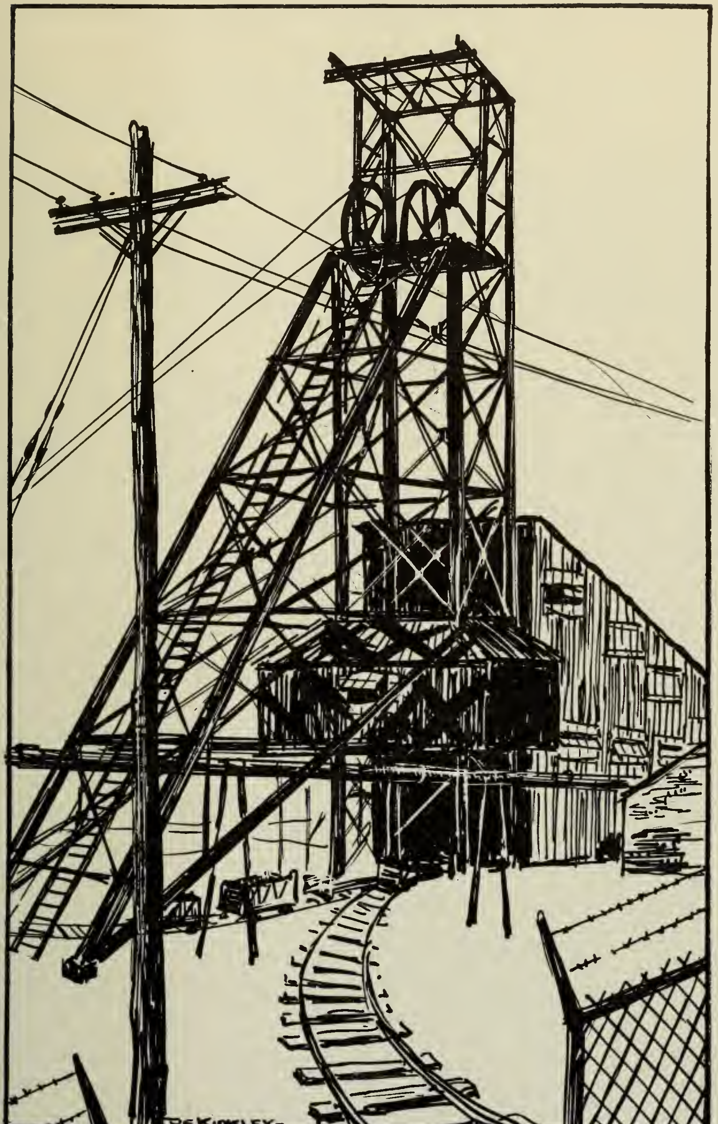
The white mist rising is not steam, but exhaust air from the mine, condensing as it comes to the surface. Underneath it is the fan-house, where an eighteen-foot fan draws gaseous air from the mine and sees to it that pure air is constantly being circulated.

There is the engine-house, which contains the hoisting machinery that, by means of steel cables, raises and lowers the carriages in the shaft.

Near-by is an ambulance station, housing the mine ambulance and first-aid equipment. The ambulance is always in readiness to rush serious accident cases to the hospital.

Farther away is the repair shop. It contains a vast amount of machinery and employs many men who repair the mine cars, the drills, and countless other pieces of equipment used in the mines.

The colliery storehouses contain enough articles to fill a mail-order catalogue; lubricating oil, wire rope, copper wire and steel rails are a few of the supplies



Mine Shaft Hoist

stored here. Explosives used in blasting the coal are stored in specially constructed brick buildings. The detonators, or dynamite caps, are kept in a separate place fifty feet away for safety.

The prop-yard is a busy place. Trucks arrive with their loads of ready-cut props, a derrick lifts them into mine cars that carry them to the shaft, where they go underground to hold up the roofs of the mining chambers.

Those large buildings, one with many tall chimneys, are power plants. Here steam and electricity are generated to furnish power for operating the mechanical appliances used in mining and loading the coal and in compressing air to power the mining drills. Steam is furnished to run the hoisting machinery and to operate the pumps and the ventilating fans. About seven per cent of the anthracite produced by the mines is used to generate power for the mining industry.

The chemical laboratory is near the breaker. Here tests are made of coal samples for ash content; the iron and brass used at the company's foundries are tested; the water used in the boilers is analyzed, in addition to the various products used in and about the mines. Mine air is pumped underground into rub-

ber bags, and thus brought to the laboratory for testing.

The whole place resembles a gigantic ant hill, furious with activity as men and machinery go everlastingly in and out of the tunnels they have made. In the background are green fields, and, running slowly past the towering breaker, a sluggish little stream carries the acid waters pumped from the mine to the Lackawanna River, which itself supplies the fresh water used in the breaker to wash the coal.

The coal breaker towers proudly over the other buildings. It is the familiar symbol of the industry.

Everything on the surface of the mine bears a coating of coal dust. Everything one touches leaves a smudge of dirt on the hands, which visitors usually transfer to their faces.

As we walked to the compressor house to get our lamps, a group of miners passed us, and they, too, were coated with a film of black. They were on their way to the wash-house, where they would take a shower and change into their "shifting" clothes to go home.

In the wash-house iron buckets are suspended on chains attached to pulleys on the rafters. The men put their shoes in the buckets, and hang their suits on hooks attached to the base of the pail. These are

pulled up to the ceiling, where they remain until the miners return in the morning, when they hang up their street clothes in place of the mining togs. Air circulates through them and keeps them fresh, and a padlock safeguards each miner's possessions.

It was different years ago, when miners went directly home from the pit. They would walk like dim shadows through the streets. Each man would be in his working clothes, on his head a cotton cap with a kerosene lamp attached, and in his hands a dinner pail and an empty water bottle. The only unblackened portion of his face would be the rims of his eyes.

Miners who rode the street cars were always sure of a seat, and no one jostled or pushed them. Even after he had washed and changed, a miner could not always hide the nature of his work. He was usually branded with the mark of the mines, blue scars on his face, caused by the faulty firing of explosives underground. Nowadays the explosives used are less dangerous and more care is used in firing them.

We entered the compressor house, where power for the mining drills is created by an electric turbine that compresses the air and maintains it at an equal force in various tanks throughout the mine.

In a panel near the wall, rows of mine lamp batteries

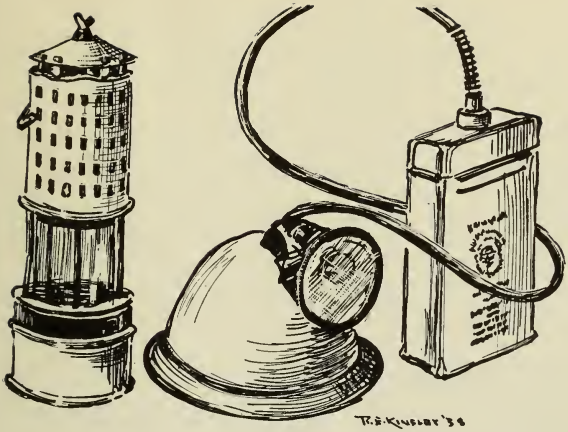
were being charged for the next shift. From one of these rows Mr. Reese took two lamps for our use. They looked like stumpy flashlights attached to batteries by long wires. Mr. Reese hooked the battery case to the back of the heavy belt he wore, drew the lamp cord and the lamp up over the back of his neck, and fastened the lamp to the front of his "hard-boiled" hat.

This position on the hat is convenient for the miner. His hands are free for work, and the light follows his glance. Where he works he looks, and where he looks it shines. Everywhere else is the blackness of the mine and the gleam of the coal as it catches stray beams of light from the lamp.

Having neither hat nor belt, I simply placed the batteries in the pocket of my coat and carried the lamp in my hand.

Mr. Reese pointed out several different types of miners' lamps. The lamp in most general use in the mines today is the carbide lamp, which generates acetylene gas by the process of allowing drops of water to drip on a small container of carbide. When the lamp is lit, a reflector back of the flame throws the light forward.

But carbide lamps cannot be used in gaseous mines, for there the naked flame would ignite the gas and re-



Safety Lamps

sult in an explosion. Until the invention of the Davy Lamp in England in 1815, thousands of miners lost their lives because of explosions in the mines. Sir Humphrey Davy, the British scientist and inventor, became deeply concerned over the menace of the open lamp, and turned his genius toward finding a remedy for the alarming situation.

The result was the Davy Safety Lamp, which protects the flame from contact with the air by a cylinder of wire gauze. This lamp not only prevents the occurrence of a major explosion, but also warns the miner of the presence of dangerous gas. When the lighted

lamp comes in contact with an explosive mixture of air and mine gas, the flame suddenly enlarges, and the observant miner retreats to a place of safety.

If the lamp is not withdrawn soon enough, a series of explosions may occur within the cylinder. These will overheat the gauze and allow the flame to escape and explode the surrounding air. Thus a safety lamp is safe only in the hands of one who knows how to use it.

A careful miner slowly and carefully lowers his lamp the instant it indicates dangerous gas, smothers it under his coat to keep it from further contact with the gas, and immediately retreats. He lowers the lamp because most gas is near the roof, and lowers it slowly to prevent the flame blowing out into the explosive air.

Many other types of safety lamps have been invented since Davy's discovery, most of them using the same principle, but with improvements, especially in regard to the amount of light given off. The old type Davy lamp produced a rather feeble light, because of the wire gauze. Present-day safety lamps place the gauze, in three thicknesses, in a lower chamber and add a glass chimney for the purpose of giving a better light. The new Davy lamp places the glass chimney below, the gauze above. They are fueled by naphtha in place of the kerosene and whale oils originally used.

The electric lamps that we were equipped with are coming into general use now, but their use is not always advisable because they do not detect the presence of gas.

After every blasting operation, a miner must test for gas, for each new cut of coal releases it in varying amounts. In addition, a Fire Boss makes his rounds every morning, usually starting about two o'clock, before the miners and other men arrive at work, and he tests every working area for gas that may have accumulated during the night.

If his safety lamp, held near the roof, indicates a dangerous condition, he immediately barricades the chamber, chalks a warning on the boards, and leaves a notice at his shanty near the shaft, where the miners report and learn whether or not their working places are free from gas. He also takes the necessary steps to remove the accumulation of gas. He initials and dates the places free from gas.

The Fire Boss also reports other dangerous conditions, such as bad roof or broken timbers.

Many mines today work in three shifts, and thus make such inspection unnecessary, since the working places are not idle long enough to allow gas to accumulate.

Chapter IV

DOWN THE SHAFT

THE shaft head was an exciting place. Coal cages slid silently and swiftly up and down the black abyss—empty cars going down, full cars coming up. The loaded cars banged and clattered as they were tipped near the top of the hoist, fifty feet above. The coal set up a roar as it went down the chute to the conveyor belt.

The engine-house was near, and we stopped for a moment to see the engineer and the Dickson steam engines with double eight-foot drums, on which were wound the cables that hoisted the cages in the shaft. The engineer watched his engines closely as they sprawled throbbing at his feet. He knew that upon him and the condition of his machinery depended the lives of many men. I thought of it, too, as I realized that soon I would be going down that shaft, while he pulled levers that would send us down as fast or as slowly as he wished.

"Send us down smoothly, won't you George?" Mr. Reese suggested.

George's eyes twinkled as he glanced at the arrows that told him the exact location of the many carriages. Not knowing whether the twinkle was of mischief or of kindliness, I could only hope that George wasn't a practical joker.

"We'll go down in a coal cage, an open carriage that carries the coal cars," Mr. Reese said as we stood at the head of the shaft, "so that you can see how the miners used to, and sometimes still do, enter the mine. Now, of course, all mines are equipped with man carriages, enclosed steel elevators that protect the men from falling rock in the shaft, and are safer in all ways."

I glanced into the blackness below, and for a panicky moment thought of retreat. But just then an empty coal car suddenly and silently appeared in front of us, Mr. Reese stepped in to show how it was done, and I had to follow.

"Hang on to one of these rings." I saw several iron rings attached by lengths of chain to an iron bar above my head. "Hang on and don't be afraid." I quickly followed the first suggestion and hung on tight, but I couldn't do a thing about the second.

Then we went down. It might have been a smooth

ride. All I knew was that it seemed fast. I felt that part of me must surely be left at the top of the shaft, while the rest sank swiftly into nothingness.

The shaft, massive, heavily concreted and timbered at the top levels, was very sturdily built. It was divided into five different compartments, two for the hoisting of coal, one for the man carriage and supplies, another for the airway, and the remaining compartment for the accommodation of cables and pipes carrying the electricity, steam, and compressed air needed in the mine. There was a water-pipe, too, which was once used to carry drinking water for the mine mules. There are few mules in the mines now. Electric locomotives, shaker chutes, and conveyor belts have taken their places.

"Watch the rock strata," Mr. Reese suggested. Didn't he realize I couldn't open my eyes? But I did, eventually, for after all I was here to see a mine, and I saw what appeared to be mile after mile of dripping rock rushing past us. Actually, it was only a number of feet, but it seemed to me that at the speed we were traveling it should be miles.

"Here's the first landing." For one flashing moment I saw a hole in the wall, a coal car, and a black cavern stretching from it. This was the first bed of coal, the

Four Foot Bed, which stretched a devious path for many miles underground.

We passed another layer of rock, then another landing, the Diamond Bed, Mr. Reese called it, and then came to a sudden stop. This was the landing of the Fourteen Foot Bed, and the one we were to explore. It was not the bottom of the mine, for there were several other layers of coal still lower, all thinner, though, than this one.

As we stepped out of the cage Mr. Reese asked me how I liked the ride and, while I tried to recover breath enough to answer, continued, "George gave us a smooth ride. I wish you could be on sometime when the men go down. You drop like lead. Then suddenly George tightens up on the cable. For a few seconds you think the car is going to break loose and stubbornly keep on going down, but then it changes its mind and stops. Until you become used to it, that stop makes you seasick. But the ride is quite safe, and a speedy way of getting to work."

I nodded weakly and gratefully realized that no matter what I had thought of the ride, the engineer's twinkle had been one of kindliness—he had let us down slowly!

Chapter V

SUBWAY

NOW out of the shaft and actually in the mine, two hundred feet underground, I became conscious of a multitude of noises. The steel cables of the shaft creaked and groaned. The empty coal cars clattered as they were bumped off the cages, and the full cars rumbled as they moved on.

A mine is not a cheerful place. Only two hundred feet underground, you still feel the weight of ages pressing in on all sides. The glittering of the coal walls as your lamp strikes them reminds you that forests that had seen the suns of two hundred million years ago were buried here, and these gleaming caverns seem haunted by the ghosts of that incredibly distant age.

And you know that these few hundred feet that separate you from the surface contain millions of tons of rock and coal that can come crashing down to crush you, should weaknesses develop in the supporting pillars.

Mine Shaft Entrance Underground

The gangways near the shaft were well kept. The roof was high, the ground smooth, the tracks solidly laid, and the walls in most places concreted and white-washed. Over-head was a tangle of conduits and wires carrying electrical power and compressed air to the working places of the mine. Electric lights hung from the roof and illuminated the many rooms and gangways concentrated near the shaft.

On one of the walls was an old-fashioned telephone box, and Mr. Reese explained that the main section of the underground workings were in communication with each other and with the surface. He pointed to a chart on the wall.

"You see? Just like a country phone. You turn the handle to get your party, according to the signals on this chart. A long and two shorts is the engine-house, and so forth. And here," he continued, "is the peg board where the men peg in and out. It is our system of checking on the whereabouts of the men. When a miner reports for work he takes a peg and places it in the hole above his number. When he is through for the day he removes the peg. In this way we know what men are working and how many are in the mine."

In addition to the peg system, a record of the daily starting time and quitting time of the employees is kept

by the section foremen. These men act as assistants to the mine foremen.

"Over here is our first aid room, or hospital, where accident cases are brought in and attended to. If the injuries are slight, the miner returns to his work. If serious, he is rushed to a hospital in a motor ambulance.

I peered into the whitewashed hole in the wall. There was a rather large room, a cot, and a cabinet against the wall. Beyond was another room, smaller, and containing a table and chairs. The remains of a lunch were on the table, and a man came out, wiping his mouth.

"Cafeteria, too?" I asked, and Mr. Reese smiled.

"Some of the mine bosses eat their lunches there," he explained.

On the other side of the gangway was another room in the wall. It was lined with benches, and here the men sat at the end of their shift, while waiting for the elevator that would hoist them to the top of the shaft.

A train of loaded coal cars came rumbling toward us out of the darkness. A little point of light became larger, and I jumped quickly from the track on which I was standing, into a pool of rusty looking water. Mr. Reese was worried.

"I'm sorry," he said. "I should have told you. The

cars don't run on this track. They switch off to the main track before they reach us."

At that moment the train of cars of newly blasted coal turned noisily onto the other track and went banging along to the shaft.

I stayed off the tracks as much as possible after that, even though it meant stepping unsteadily over pools and sometimes brushing against the walls of coal.

The miners themselves have a keen sense of danger underground. They can tell by the sounds exactly how a train of cars is behaving. The normal noise does not disturb them, but the least sound that is out of harmony with the usual symphony is at once detected, and causes the miner to be instantly on guard. He can tell by the sound if a train of cars is rushing toward him out of control, even from a distance, and thus has time to get out of the way. An unheeding miner is sometimes run down, or pinned against a prop that has been placed too close to the tracks.

Underground transportation is the carrying of the newly blasted coal from the miner's chamber to the shaft. As in all other phases of the mining industry, methods of transportation are being constantly improved.

Modern power for drawing the coal cars is the elec-

tric locomotive, which is operated either from an overhead trolley or from storage batteries in the motor itself. The latest means of carrying coal to the shaft is the conveyor belt.

The conveyor belt is of rubber composition several feet wide, electrically run on rollers from the coal face to the main gangway, or to the shaft. A slope mine may contain a network of these belts, which not only carry the coal out of the mine, but into the breaker itself.

In the mine we are visiting, conveyor belts, shaker chutes, and scraper loaders are used in conveying the coal from the working place to the mine cars in the gangway.

These methods are far removed from the old-time mule power for pulling the cars, which is still used in mines that do not produce enough coal to warrant the use of the more costly electrical equipment.

The mules are stabled underground, and insist on, and get, the best of care. A mine mule is a very wise animal. He will work willingly and well, up to a certain point. But when he feels that he has worked enough and is nearly losing his strength, he will become stubborn and refuse to move. Then there is nothing to be done but return him to the surface,

Underground Electric Transportation

where rest and pasturage in the sun restore him to his original vigor. A horse has not this protective stubbornness and will work until he dies. He relies upon his owner to take care of him.

Mine mules do not become blind, as some suppose. They have better vision underground than humans have, for their eyes contain reflectors, as do the eyes of other animals, and these reflectors increase their vision in dark places. When they are suddenly brought into the sunshine, however, after months underground, they become temporarily blinded by the light. In a few days their eyes become adjusted to the sun, and their vision returns.

Years ago, boys twelve to fourteen years old used to drive the mules in the mines and were called driver boys. Many fine men in public life today look back with pride to the days when they worked as boys in the mines. But children have a happier life today, and these men would shudder at the thought of their own boys spending their growing years in the depths of a coal mine.

Before mules, oxen were used to haul the coal to the shaft, and before that, in the dark days of mining, little boys and girls in European mines used to carry the coal. They would work all day in the sunless

caverns, stumbling over fallen rock, the heavy lumps of coal clasped to their chests, and squeezing into tunnels too narrow for the men to enter. Entire families would work together, the father and older boys digging out the coal, while the mother and the smaller children pulled it in wagons to the shaft.

Chapter VI

THE HEART OF THE MINE

"YOU have probably been wondering what that commotion is," commented Mr. Reese, as we approached a cavern that seemed to be the home of a thousand snarling wildcats.

He explained that this was one of the pumps, and what a noisy piece of machinery it was! It was impossible to hear anything but the clamor of the engine and the wheezing of the pistons as they throbbed at their work. An engineer sat near by, gazing tolerantly at the inferno he controlled.

The function of the pumps is of great importance in operating a mine, for their work is to keep the workings free from the water that is constantly flowing into the mine from myriads of underground springs, and from the water that, in spite of special precautions, runs in from the surface through the many fissures and cracks in the earth.

The underground water is acrid and reddish with sulphuric acid and iron pyrites. The parts of the pump that come in contact with it are of bronze, and discharge pipes are often lined with wood to keep the corrosive water from contact with the metal.

Water accumulates in such quantities in the underground workings that, from this one mine alone, 15,000,000 gallons are pumped out every twenty-four hours. Twelve tons of water are removed for each ton of coal produced.

Mining engineers boast that, with the pumping equipment of this company, they could drain one of the largest lakes in Pennsylvania completely dry in one month. They pump an equal amount of water from the mines every month in the year.

In its journey through this region, the Lackawanna River contributes largely to the flooding of the mines. Its waters run mischievously into the workings, as if to look things over down below, but before they can go very far, they are hastily pumped out, only to repeat the process in the other mines on the river's route.

Mining engineers, in plotting the removal of the coal, are always careful to see that the coal beneath and adjoining a river bed is left solid. Otherwise, the river

bed would be liable to crack or cave, especially if it contained quicksand, and release the river itself into the mine.

To allow the ever-accumulating water to be removed, gangways in the mines are always driven on a slight incline, the water running off to a storage place called the sump. The main sump is at the very bottom of the mine, and from here the water is pumped to the surface, where it flows into the little stream that carries it to the Lackawanna River.

In spite of the slope, water sometimes collects in pools in the miner's working place. In this case it is drawn off by means of hand pumps or syphons, or released into lower workings by the drilling of bore-holes through the floor to the next level, where it can be run off to the sump.

Workings of abandoned mines, where pumping has been discontinued, soon become flooded. This would be the fate of all mines were it not for the work of the constantly throbbing pumps, which dare not stop as long as the mine is to function.

Chapter VII

GAS AND RATS

WE LEFT the noise of the pumps and began our long trip into the furthermost workings of the mine, where we were to see miners actually at work taking out the coal.

The way became rougher, and I lost all sense of direction. I knew that only by accident could I, by myself, find the way back to the shaft. I asked Mr. Reese how he managed to find his way about, and he said that after three months a mine worker knows exactly where he is at all times. He can tell this by the nature of the coal, the depth of the bed, the appearance of the tracks and timbers, and many other landmarks he learns to recognize.

For the first three months, though, a mine worker is usually very much in the dark. He often becomes lost in the tunnels and sometimes wanders miles out of his way before being rescued.

The concrete walls gave way to sides of the coal itself, the coal that cannot be taken out, because it must be left to support the surface and to keep the many honeycombed levels from caving in on each other.

The roof was low and of dull gray-blue slate. For as far as I could see into the dimness of the tunnel, it was supported by sets of timber. These consist of two props, one on each side of the gangway, with a cross-piece overhead, notched and joined to form a supporting arch.

This timbering of a mine is important and necessary, although the purpose of the props is not, as I supposed, to keep the mine from caving in. The support of the roof is insured by engineering knowledge of how wide a tunnel can be to support its arch, and on the correct spacing and circumference of the pillars of coal left standing in the beds. They should be at least 125 feet around and larger in the lower levels, where the pressure is greatest.

In the early days of anthracite mining, the coal pillars were sometimes too small to support the strata, and the result was often a general caving-in of the mined tunnels. Hundreds of men have been trapped and killed by these "squeezes," as they are called. Cave-ins occurred, too, because pillars were not always arranged

in proper positions in the different levels. They should be directly over each other, for, when they are not, one pillar with its burden of overlying strata is bearing down over an unsupported section of the lower level, which weakens and caves.

The wooden props would crumble instantly under the pressure of a roof having no other support; the purpose of the timbering is to prevent loose pieces of rock falling from the roof.

This fall of rock is one of the serious dangers of the mine, a danger that is constantly guarded against. The Fire Boss carefully examines the roof every day on his rounds, and the first question he asks a miner is "How's your roof today?"

The miner then tests it for him by prodding at it with an iron bar, while at the same time he places his other hand against the roof to see if his prodding is causing vibrations. If there is a vibration he knows that the roof is unsafe, and a prop is brought and adjusted to hold up the loosened rock. Sometimes loose rock can be knocked down by a crowbar, and this is done whenever possible.

Although the timbers cannot support the roof in case of a real cave-in, they do serve as a warning of ap-

proaching collapse by the moaning they set up when the pressure begins.

The natural and gradual pressure of the roof on the props crushes them eventually, and they must be renewed at least every eighteen months. Sometimes the pressure is so great that it is necessary to renew them every three months. In a pillar robbing operation they can snap within an hour. Dry rot and wet rot hasten the decay of mine timbers.

Most of the props come from the forests of the surrounding hillsides. The trees go underground with green leaves still clinging to the bark, to take the place of the blackened remains of trees long dead.

Several miners passed us as we trudged along, over ground that was becoming more rocky and uneven all the time. "Hello," said the men cheerfully, and passed on, leaving a peculiar acrid odor.

"Is that the smell of mine gas?" I asked.

"No," Mr. Reese smiled. "That is the smell of the carbide in their lamps. Did you notice the open flame?"

"But isn't it dangerous to be underground with an open lamp? Or isn't this a gaseous mine?"

"This may be rated as a gaseous mine, but these men

are doing rock work close to the shaft, so there is little danger of explosion. Gas accumulates in the working places where coal is being blasted. It is released with each cut of coal, and that is why the ventilation of a mine is so important. Fresh air must be brought right into every working place and circulated in such quantities that dangerous gases are diluted and blown away. Air that contains more than five to fifteen per cent of mine gas is explosive."

A mine is ventilated in this manner; as a gangway is driven into the bed of coal, a similar passage is blasted out thirty feet away and connected with the gangway by means of a cross-cut driven through the coal. The ventilating fan on the surface draws out the gaseous air through the airway and up the air compartment in the shaft, while fresh air rushes down the carriage shaft and into the gangway.

As mining chambers are driven off the gangway, the air is allowed to circulate through them by means of further cross-cuts, which are blasted out as the work advances. To keep the air from going into places where it is no longer needed, cross-cuts that have been passed by are sealed up with concrete.

Brattice screens are used in the chambers to assist in the circulation of air. They are made of wooden

frames and closely-woven, air-proof brattice cloth and can be moved about as needed.

Air-stoppings are also needed in gangways through which the mine cars travel. In this case, strong doors are built, which open automatically as the cars approach. The doors are in pairs about sixty feet apart, or far enough to allow a train of ten cars to stand between them with the doors closed. In gaseous mines, one door must be closed at all times, to prevent the escape of fresh air from the working places.

Years ago boys used to open and close the doors. They would sit all day in the darkness, waiting for the noise of the approaching cars that would be their signal to get ready to open the doors.

Where the mines are shallow, natural ventilation is sufficient. This is brought about by the difference in temperature between the outside air and the air underground. In the early days of mining, when most of the mining was done in the surface beds, this natural ventilation was all that was needed. Later, as mining went deeper and more deviously underground, ventilation was brought about by the lighting of fires at the foot of the shaft. This resulted in increased changes in temperature, thus causing a draft which expelled the foul air and drew in fresh currents.

Nine tons of air are pumped into this modern mine for every ton of coal that is taken out, or at the rate of 25,000 cubic feet per man. This is much more than is ordinarily necessary, but sometimes unusually large pockets of gas are released by the blasting, and there must be enough air to dilute and carry away this gas, or an explosion will result.

Gas may sometimes accumulate so suddenly that the ventilation cannot cope with it and an explosion occurs. A cave-in in overlying coal beds can cause deep cracks in the roof of the lower bed, and through this large quantities of gas are suddenly released. Pockets of gas are sometimes exploded, with disastrous results, by sparks from the trolley line of a passing electric locomotive.

From the gangway we were traveling, a road suddenly forked off into a place where men were shoveling and heaving at a mass of fallen rock. "A cave-in?" I asked apprehensively, but Mr. Reese said no, that these were company miners, driving a new gangway through the rock to the next tunnel to make a short cut for the coal cars. "Dead work," it is called, because it produces no coal. The coal had already been taken out here, but in a vein too thin for the cars to go through.

The rock was tough and hard to break. The air was

full of dust from the blasting, and the men breathed heavily as they lifted incredibly large pieces of rock onto the conveyor belt that took it and slid it into a coal car a few yards away.

The car would take it to the gangway, where it would be stored behind props and called "gob," later to be used as needed in the mine. It could also be loaded and taken out to the surface and dumped along the shores of the little stream, or on the rock pile.

A shadow slipped past us and disappeared in the gloom. Mr. Reese looked at me quickly and smiled.

"You don't know what that was, do you?" I shook my head.

"You mustn't be alarmed if you see quite a few of them. They won't hurt you. In fact, they'll come up to you, if you whistle."

"But what are they?" I had seen only a shadow.

"Rats," said Mr. Reese. "And I hope you won't be like some of our visitors, who say they won't go a step further when they hear of them. They really are harmless. The men make pets of them and leave them food from their lunches. Mine rats have always been good friends of the miners, for they have an uncanny feeling for danger. When the rats play around contentedly, the miner can feel safe. But should they come rushing

past, making a bee-line for the shaft, the miner knows that it is time for him to run, too. The rats know before he does that a "squeeze" is coming, because they have better hearing. They can hear sounds that are too high or too low for human ears."

My opinion of rats changed slightly, then, but I still couldn't think lovingly of one rushing over my feet, as Mr. Reese said they sometimes do. And I don't think I'd like to pet one, even if he had saved me from an underground death.

"Do they warn of gas, too?" I asked.

"No. They're not much good for gas. Rats run along the ground, while gas rises to the roof. The gap between the rat and the gas is too great. In the olden days the men used to bring canaries underground to detect gas. The deadly mine gases are odorless and give no warning of their presence. Before safety lamps, a miner could only use his experience as to when they were liable to be released, or use little creatures like the canary, who would die in their cage at the first sign of gas, and in dying save the life of the miner, who would hastily leave the place. But he would take the bird with him, for sometimes it did not die and could be revived in the fresh air."

Chapter VIII

FIRST MINING

THE gangway suddenly forked off, and Mr. Reese halted.

"Do you mind waiting here, while I go ahead and see if they are working this chamber today? I won't be long. It's just around this corner; not very far but there's no use in your making the trip if the men aren't working here."

I nodded, and he left, and I watched his light disappear around the bend.

I suddenly felt very much alone in the narrow, low-roofed tunnel that seemed to have no end. There was no life, and, save for my lamp, complete darkness. On impulse, I switched off my light, and knew a blackness never before experienced. No light, no sound, no life; only a terrible feeling of oppression. Of millions of tons of coal and rock above my head, held up only by man's knowledge of the number of feet in width a

tunnel must be to support the roof, and how much coal must be left in the pillars.

There was a feeling of death, of breathing the dust of ages, all about me. Deep in this weird world, a

Drilling

stranger could wander for weeks without finding an exit. Trapped underground, he would eventually experience one of many deaths. He could die of starvation, or, with the pumps stopped, could drown slowly as the water would gradually rise in the levels. With

the fan shut off, he could inhale deadly gas, or suffocate from lack of air. Or the entire mine could suddenly collapse and crush out his life, or a small piece of rock could fall from the roof and accomplish the same thing.

I quickly switched on the light and heard the welcome sound of footsteps hurrying toward me.

We were soon facing the solid wall of coal that was to be blasted down. Here a miner and his two laborers were preparing the charge. The miner took a long compressed air drill, and with the help of the laborers, who held the drill high, he guided it into the coal. The drill ate rapidly into the solid face and made a great deal of noise. Black dust puffed out, and then the drill was removed. The hole it had bored was six feet deep, and was the first of a series the miner would drill in this wall of coal.

The coal is sometimes undercut before it is blasted, especially in thin beds. This undercutting is the taking out of a layer of coal about six inches high and to a depth of six feet at the bottom of the face. This process allows the rest of the coal to be more easily and less destructively blasted down. Undercutting machines now do the work a miner used to do by means of pick and shovel. The machine drives a chain of strong steel

teeth into the wall of coal, and these teeth literally tear out the required layer.

The laborers left the chamber, and Mr. Reese said we had better leave, too, while the miner inserted the pellet of black powder, "permissible explosive," that was to blast down the section of coal. Long wires were inserted with the powder; the hole was blocked with damp dust from the floor, and the wires then connected with the distant battery.

The mining chamber was now empty. The miner, the laborers, Mr. Reese, and I were many yards away and around a corner, so that pieces of coal from the blast could not hit us. Miners in the adjoining workings had been warned that a blast was to be fired. The miner threw in the switch. A dull boom answered from the coal wall, a rush of air struck us, and coal dust eddied about in the currents set going by the blast.

After the miner had tested for gas and loose rock, we returned to the chamber to find a gaping hole in the wall and a litter of coal in all sizes on the floor. The laborers immediately began shoveling this into the shaker chute, which is a long steel trough used to carry the coal to the mine cars waiting in the gangway. One of the men pressed a button on the chute; a bell rang faintly in the gangway, and immediately the chute was

set in motion, a jerking movement that sent the coal sliding toward the coal car.

In the meantime, the miner was not idle. He was getting ready to drill the next hole, that is, to repeat the process we had just witnessed, until the entire wall to a depth of about six feet would be blasted down.

This man was a *contract* miner, which means that he was paid so much for each car of coal he sent out of the mine. The laborers were his employees whom he paid from his own earnings. *Company* miners are employed by the mining company to do routine work in the mines, such as the blasting of rock for new tunnels and a variety of jobs that produce no coal. *Consideration* miners contract to do a certain piece of work for a certain price, usually a fixed hourly rate. The contract miner is to a great extent his own boss, hiring his own laborers and receiving a price for the coal he sends to the surface.

For a few minutes we watched the coal slide by on the chute, while Mr. Reese explained about this method of mining.

"We call it the 'chamber and pillar' method," he said. "The coal is taken out in 'rooms,' and large pillars of coal are left to support the roof. Later on, when a section has been mined, 'first mining' it is

called, we come back and take the coal from the pillars. This is secondary mining, or 'robbing,' because, starting from the point farthest from the shaft, we rob the pillars and let the roof cave in."

"That must be very dangerous work."

"It is. It is the most hazardous phase of mining and requires the most skill, both on the part of the engineers who plot the work, and the miners who take out the pillar coal."

"And the roof actually caves in as the men work?"

"Yes, but it is controlled caving. The miner blasts down the furthermost section of the pillar, immediately places props to hold up the roof while the coal is loaded, and then retreats as the props are shattered under the pressure of the falling roof. When the roof is all down, he returns to the pillar and takes off another slice, props the roof again, retreats and waits for the roar of the roof, then begins again. It is to his advantage to have the roof cave where he directs it, for this takes pressure off other portions, and prevents a cave-in in an unexpected spot, where the miners might be caught. If a collapse is too slow in coming, a miner will sometimes blast the props to bring it on."

"Does the cave-in extend up to the surface; does everything on top come down when the roof collapses?"

"Usually robbing is first done on the upper beds and gradually brought down through the lower levels. When the beds are robbed, the collapsed roof consists of solid rock, since the coal has all been taken out above, and the chambers caved. There is plenty of rock, though, and the cave does extend to the surface."

Mr. Reese thought for a moment, and then said suddenly, "Would you like to see a robbing operation?"

I said "yes," immediately, with all the eagerness of a person who merely answers a polite question.

"Very well, then. They're taking out pillars up on Number One—the Farm. It's a slope, and we'll go down tomorrow and see the work. All right?"

"All right," I answered weakly.

"Tomorrow morning at 8:30," Mr. Reese said.

Chapter IX

ROBBING

AT 8:30 the next morning we arrived at the "Farm," which, besides being a farm, is also a coal mine.

The surface was a curious mingling of coal mining and farming. Mine buildings clustered about the entrance to the slope. The fan-house, the superintendent's office, and the rock pile stood in the midst of fields of newly cut hay. Among the stalks of a corn field, the automobiles of the miners squatted like beetles on a sunny slope.

A big red building seemed to belong to the farming end, but it was a wolf in sheep's clothing. Underneath its rural exterior it housed the vibrant engines and cable-clad drums of the hoisting machinery that pulled the mine cars up the slope from the underground. Two mules were also housed there, remnants of the days when the barn stabled hundreds of them. These two survivors work on the surface, doing odd jobs of transportation.

My guide for this mine was Mr. Lewis, a senior engineer of the coal mining company. In the superintendent's office he introduced me to a twinkly-eyed Welshman named Davis, who had worked in the mines forty-five years, thirty in this country and fifteen in Wales. After nearly half a century of this most hazardous work, he was now a merry-eyed, powerful man with a small blue powder mark on his nose and the memory of two broken toes to remind him of his most harrowing experience in the mines.

"That was the time, six years ago, when I really had to run for my life. I was on my rounds in this mine, when suddenly I heard rumblings in the workings. I knew at once that a "squeeze" was in progress. The rumbling grew to a roar, and, shouting a warning to any of the men who might be within hearing, I picked up my heels and ran.

"I'll never forget that run. It was a race with death, for the cave-in of the caverns followed me every foot of the way. Timbers were snapping like match sticks. The collapsing roof was like a monster at my back, breathing hot blasts of air and roaring like a million lions. Once I fell and thought I was done for. But I scrambled to my feet somehow and stumbled frantically on. I kept to the side of the gangway as

the safest place, should the "squeeze" catch up with me, and eventually reached the surface.

"I went back with rescue crews for the other men, but there was nothing to be done. They had been trapped and killed. That night I discovered that I had two broken toes. I don't know to this day how I got them, but it was probably when I stumbled and fell."

"One of the fine things about this work," commented one of the men, "is the willingness of the men to risk their lives in rescue work. Whenever there is trouble in the mines, volunteers are never lacking to go down into the danger zone, into what is often almost certain disaster. To rescue an injured worker men will crawl for miles over caved-in ground, squeezing through long tunnels barely large enough to hold them, knowing that at any moment they are liable to release rock that will crush them.

"The work of rescuing others is one phase of the industry where workers and officials are in full accord. They will work together wholeheartedly and heroically, sometimes giving their lives in their attempts to save the others. After any accident in the mines, the officials of the company are the first to go down. They

investigate, direct the work of the rescue crews, and make their reports, right from the front."

Again I was equipped with a coat and lamp and soft cap, while Mr. Lewis, like Mr. Reese, himself put on a hard-boiled hat. Then we began our long walk down the slope.

A slope is like a shaft, with the exception, of course, that it slopes gradually into the underground workings instead of going down vertically. The coal cars are drawn up by cables, but on tracks instead of in elevators. There is a carriageway for the coal, airway for the exhaust air, and manway for the men.

We walked down the manway, and, as I looked back, the glimmer of light at the head of the slope grew smaller and smaller until it reached pinpoint proportions. Then it went out entirely. We presently reached one of the lower coal beds and left the slope to enter the gangways of this level.

Here, as in the other mine, were electric lights, whitewashed walls, and a hospital. The place being empty, we didn't linger, but with Mr. Lewis leading the way, set off for the working place.

This we reached after many turns in the coal-bordered tunnels, often under a roof so low that we had

to crouch down, and up steep inclines where the coal bed slanted upwards.

We passed several cogs along the side, which were pillars of timbers arranged log cabin fashion and filled with gob or rock from the mine. They held up the roof, which, in the early days of mining this section, had been left with insufficient support, and took the place of the coal pillars that should have been there.

This mine had been first-mined many years ago, and now the miners were engaged in secondary mining, taking out the coal pillars that had been left to hold up the roof. They had begun at the furthermost parts, robbing the pillars and allowing the roof to collapse, as they retreated toward the entrance.

This robbing process ends forever the mining in the section in which it is carried out. The coal is all removed, and nothing remains but the fallen rock and crumpled timbers. Hundreds of tons of coal are recovered from each pillar, which is usually twenty-five feet wide by fifty feet long, to the height of the coal bed, usually about seven feet.

Although I was more accustomed to the underground now, I found this mine a nerve-wracking place. There were long reaches of unsupported roof, relic of the old,

less careful days, and yawning, caved-in holes that gave glimpses of other tunnels, many feet below.

There were two of these caverns in the working place we now entered, one on each side. The ground we stood on was broken and caved, and through one of the holes I could see the coal pillar in the lower level, directly under the pillar the miner was blasting. Straight ahead was a jumble of broken props and fallen rock. That was the collapsed roof, which broken down state would soon be the fate of the very roof under which we were now standing.

We scrambled over a huge boulder of slate and said "hello" to the miner and his three laborers.

"Going to blast now?" asked Mr. Lewis, and the miner said they were. In fact, the laborers were bringing up the drill and preparing to set it against the face of the coal pillar. This was the last of a series of blasts, and the final drilling before the next collapse of roof.

As the drill clattered like a machine gun through the solid coal, I suddenly felt the ground slide from under me and heard the swish of sliding coal at my feet.

I yelled, of course, and grabbed for the nearest support, which happened to be the floor. Mr. Lewis pulled me to my feet again, and I leaned against a prop

for a moment, but hurriedly transferred my weight to my own feet, when I realized that this prop was due to snap when the roof would presently cave in. I was very much embarrassed.

The miner must have known it, for he said, "You mustn't feel embarrassed. The men yell, too, when unexpected sounds or movements occur. Nerves are on edge in this work, and a miner's alertness often means his life. A little slide might be the beginning of a "squeeze." Coal mining is mighty serious business.

"Who worries the most in the mine?" I asked Mr. Lewis a little later.

"Well, the responsibility for the safe conduct of the work is divided among many. The miner is usually too busy working to worry much. His foreman worries for him and constantly checks on conditions. And the mining engineers so plan the work that there is a minimum of danger involved. They make regular surveys and plot the operations so that, when a roof is to be caved in, for instance, it falls only where it is supposed to."

The hole drilled, the miner set the charge of powder, while the laborers retreated to the nearest cross-cut to await the miner and the blast. Mr. Lewis and I took

a long walk down to the gangway, where we sat on the edge of an empty coal car.

Mr. Lewis said, "I'd move over that way a little, if I were you. I don't like the look of the roof right there. We don't want any of it coming down on you."

I moved very quickly, because I didn't, either.

Presently we heard a dull boom and hurried back to the chamber to see what damage had been done.

The men were working very fast now, shoveling the coal brought down by the blast into the shaker chute. Every so often one of the laborers would lean over and swing a sledge hammer at a very large piece, breaking it so that it would slide more easily. Then the miner rang the bell, and the chute was set in motion, jerking slate, dust, and coal in all conditions and sizes down to the waiting coal car.

There was no time to be lost, for at any moment now the pillars might snap and a million-ton, two hundred-foot, thick roof of rock come caving in on us. The last remnant of its support had just been blasted down. and the wooden props couldn't hold it much longer.

The coal was quickly loaded, and we—the miner, the three laborers, Mr. Lewis and I—retreated in good order down the path of the shaker chute to the gangway. No

sooner had we reached the end than we heard the roar of the roof.

And over the roar of the subsidence came staccato explosions like claps of thunder overhead. That was the snapping of the timbers under the terrific pressure.

When the chaos finally subsided, the men went back to begin work on another pillar. The terrifying caving was all in the day's work for them, a simple operation planned by the engineers, overseen by the foreman, and executed by the miner and his men.

But I didn't go back. I was ready to leave the mine, and so was my guide. I think he was worried about me. A person who may yell at any disturbance is decidedly out of place in a mine of trigger-nerved workers.

On our way back we paused to watch a scraper-loader, which is a huge, steel, wedge-shaped scoop that is dragged by means of pulleys operated by an engine in the gangway. It goes up to the face empty, or carrying a prop for the miner, and comes back loaded with anthracite. It slides up a chute to the mine car and is there emptied.

As I turned to leave, I saw Mr. Lewis engaged in serious whispering with the foreman and wondered nervously what ominous business was afoot. Was a

"squeeze" suspected? But as they walked up I heard Mr. Lewis say, "It's like pulling teeth to get you fellows to go anywhere. I'll put you down for two tickets. All right? Two tickets for the Safety Meeting."

As we walked further away from the workings, I saw a beautiful blue light sparkling ahead and knew that we would soon be out of the mine, for that blue light was daylight.

Chapter X

UPS AND DOWNS

OUT in the world again, I breathed deeply of the sparkling air. The sunshine seemed pure gold after the darkness of the mine. Commonplace things took on a loveliness never before realized. The blackened breaker and the soaring refuse pile towered majestically against the bright sky, and even the little black stream sparkled as it glided through the fields. The air was vibrant with vigorous life. Jets of steam puffed happily away, and over many tracks railroad cars moved sedately with their loads of gleaming anthracite.

We returned to the shaft I had descended the day before and watched the coal cars go up and down, bringing out the coal. This "run-of-mine" coal that is composed of dust, slate, and anthracite in all sizes, now faces three ordeals before it is ready for market. It must be broken, cleaned, and sorted. For this purpose it must be carried to the breaker, which is, at this mine, half a mile away.

Surface Loci

In the olden days, breakers were built right over the shaft, which was a very convenient place. But, as it turned out, it was also a tragic place, for in 1869 a mine disaster occurred that resulted in state laws being passed, which prohibited the building of breakers over the mine shaft and also provided that every mine should have at least two exits.

One hundred and seventy-nine men lost their lives in this disaster when the wooden breaker at the head of the shaft of the Avondale Colliery took fire. Since this shaft was the only means of exit from the mine, the men were trapped below and, with ventilation cut off, were suffocated.

The breaker need not be half a mile away. This breaker is, because it also serves for the coal that comes from another mine on the company's property, and so it is placed between the two shafts.

In some mines the coal cars are pulled to the breaker by a small locomotive, or allowed to run by gravity, but in this modern mine another method is used for transporting the coal. The cars do not leave the shaft at the surface but continue up the elevated structure to a height of about fifty feet. From this height the cars are tipped and the coal is hurtled into a chute. The empty coal car then goes down the shaft, coun-

terbalancing a full car that is coming up in the next compartment, and which is next tipped into the wide chute.

This "run-of-mine" coal then slides into a huge sieve that is in constant jigging motion. The holes are large in this sieve, and all but the very largest pieces of coal drop through to the chute below. The pieces that remain on the sieve, being too unwieldy to send through to the breaker, are slid a short distance until they fall into a set of grinding steel teeth, which chew them into smaller pieces.

They then join the other pieces and together they reach the conveyor belt, which carries the coal smoothly and surely on its half-mile trip to the breaker.

This belt is over a mile in length, four feet wide, and in only two sections. It is made of rubber and fabric, like an automobile tire. When it was shipped to the mine in 1922 it came on twelve flat cars, rolled in a series of scrolls.

It is driven by a powerful electric motor and rolls smoothly over ball-bearing steel rollers. To protect the belt and keep the oil in the rollers from hardening, a steel and concrete housing has been built over its entire length, in which steam pipes run to maintain protective warmth. The housing is on steel stilts, which

reach skyscraper proportions as they form a bridge to carry the belt over a cut of railroad tracks that run through the property.

The coal rests securely on this belt until it approaches the foot of the breaker. Here it begins its ride up the elevated conveyor, which takes it to the top of the breaker. The coal is flushed onto this conveyor by strong jets of water and carried up by means of four foot wide steel plates called flights, attached to an endless chain.

We left the coal as it was being flooded against the flights and went into the breaker itself, where we, too, took an elevator to the top, a height of nearly four hundred feet.

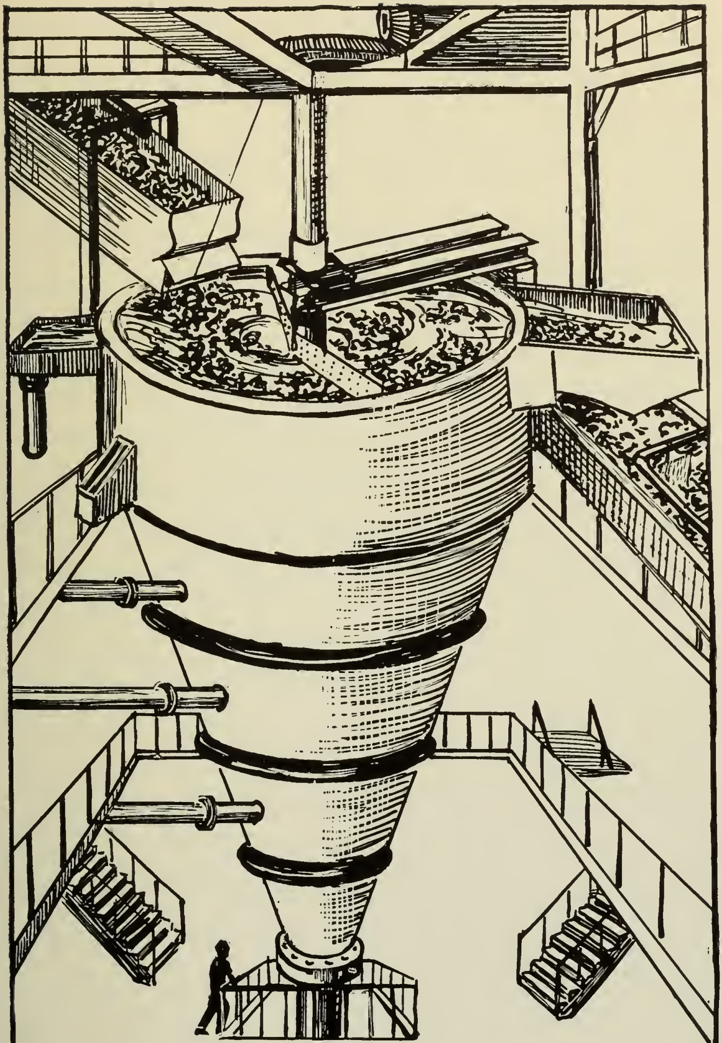
We stepped out of the elevator into an inferno of noise. The roar of the engines, the shaking of the screens, the rattling of the coal as it was jostled from one screen to another, and the swishing of the water as it washed and carried the coal combined to make an hysteria of noise and vibration that caused even this modern breaker to shudder and sway. Two million dollars worth of concrete and steel shivered convulsively at the job of sorting and cleaning little pieces of coal.

The coal we had left at the foot of the elevated con-

veyor had arrived before us and was sliding under powerful electro-magnets, which were engaged in removing any pieces of metal that may have been accidentally loaded in the mine. Pieces of mine implements, even dynamite caps, might come in with the coal; these magnets make it impossible for them to go to market with the coal.

Presently the coal was being jostled over the first series of sizing screens that served to let the small sized pieces fall through the holes, while keeping back the too-large pieces. These were sent on to steel grinders, or rolls, which steadily crunched them down into smaller pieces. All sizes then come together on a lower level and are gradually slid into the Chance Cone.

This cone, created by Dr. Henry M. Chance of Philadelphia, is a very clever invention and the very newest method of cleaning coal. Anthracite as it comes from the mine is mixed with slate, which the miner cannot remove underground owing to the darkness of his working place and the necessity for using every precious underground hour in blasting and loading the coal. These impurities must be separated and removed. It is the duty of the cone to see that this is done and that only pure anthracite, the cream of the mine, is delivered to the consumer.



The Cone Cleaner

The cone itself is a giant shell of steel having a diameter of 15 to 18 feet at the top, tapering to 2½ feet at the bottom, and having a central agitating shaft similar to that of a washing machine. The duty of this shaft is to keep the contents of the cone in constant motion.

We paused at the upper edge of the cleaner, and, as visitors usually are, I was fascinated with the manner in which it worked. It was filled nearly to the brim with a mixture of sand and water. Into this mixture a steady stream of coal kept rolling, and, because the anthracite was lighter than the sand and water, and the slate or rock heavier, the latter quickly sank to the bottom of the cone, while the anthracite floated near the top, where the motion of the water sent it skimming into an outlet chute.

A handful of pebbles and pieces of wood thrown into a pail of water illustrate the principle of the cone.

There are other methods of removing slate. One of these is called the jig method, in use today in many breakers, and another is the Rheolaveur system, which originated in Belgium. The former method uses a system of water-tight boxes, inclined sieves, pulsing water, and a plunger, which results in the coal being flushed to the top of the box, where it is drawn off, and the

impurities sinking to the bottom, where they are likewise removed.

The Rheolaveur system carries the coal down a maze of steel troughs by means of a constant flow of water. During this journey the coal rises as usual to the top and moves faster, while the impurities sink and lag behind. At certain points in the descent the impurities are trapped and thrown off, until finally, after the coal has passed through a series of these troughs, most of the impurities have been removed.

After the cleaning process, nothing remains but to sort the coal into its various commercial sizes, a process called sizing, give it a final rinsing with clean water pumped from the river, and then load it into the railroad cars and trucks waiting for it below. After a final rigid inspection for size and impurities, it goes on its way. The loaded railroad cars slide by gravity to the main line, while the empties are pulled back by a locomotive. The rails of the tracks are steam heated in winter to prevent the forming of ice that would otherwise result from the dripping of water from the coal.

During its journey through the breaker, a day's run of coal has required the services of 18,000,000 gallons of water, used both to rinse off the coal dust

and to assist the passage of the coal down the various chutes and over the sieves.

During the journey from the top of the breaker to its base, the pieces of coal have leaped in the shaking of the sieves, run swiftly down the stainless steel chutes in a rush of water, received countless shower baths from needle sprays suspended above the chutes, and whirled giddily in the cone.

By the time it is sorted it is completely tamed. The different sizes obediently travel in the proper chutes. They seem satisfied to rest quietly now that the hysteria of the jigging sieves, the grinding rolls, and the Chance Cone is over.

The sorted coal bears names that make one think of a grocery store rather than a coal mine. There is, in the order of their sizes and beginning with the largest: grate, egg, stove, chestnut, pea, buckwheat, rice, and barley coal.

A modern breaker is very different from its old-time counterpart. Many years ago breakers were all rickety wooden structures, and in place of the sieves, the grinders, and the cones, men and boys broke, sorted and cleaned the coal. The men would swing heavy picks and sledgehammers to break the coal, while

the boys would sit astride the chutes and pick out the pieces of slate that came sliding by with the coal.

The air would be black with coal dust, and the men and boys would cough and throw pieces of slate at one another and wipe perspiring faces with blackened hands.

Now the breaker is manned by engineers and attendants, who control the intricate machinery by means of signals and a central control board that bristles with switches and levers. And young boys no longer work in the mines.

In the old days, due to the crude and inefficient methods, much slate or rock was left attached to the coal, and much coal was in the same way thrown to the culm pile. If there was more slate or rock than coal on a piece it was discarded; if more coal than slate or rock, it was retained.

Now, with improved equipment for the burning of smaller sizes of anthracite, and with the advantage of the cone cleaner, most of the culm has been hauled back to the breaker, where, re-broken in the steel teeth, re-cleaned in the cone, it has yielded a large amount of pure anthracite. Anthracite that is now being sent to market is nearly one hundred per cent pure.

Chapter XI

SILT

ANOTHER product of the breaker is silt, which is anthracite in particles so fine that until recently it was thought to have no commercial value and was thrown away. As a result of the work of the Anthracite Research Institute, valuable uses have now been found for it.

It is pressed into brickettes for fuel, used in various chemical processes, including the manufacture of certain paints, and, in very small amounts, is found in every telephone transmitter in the United States and Canada. In the telephone the particles of silt move or pack together as the diaphragm of the instrument vibrates, thus reproducing the modulations of sound at the other end of the wire, and clarifying the conversation.

Some industries use the silt as fuel in their power plants, where by special machinery it is fired as it is

blown into the furnace. It burns so rapidly while in motion, and with such intense heat, that it is reduced to ashes before it lands on the grates.

The Scranton Electric Company uses forty railroad cars or two thousand tons of this silt a day in firing their furnaces. The furnaces produce the steam that runs the dynamos that make the electricity to furnish light and power for the city of Scranton. The mine companies, too, use silt in their power plants, but more generally use the barley size anthracite.

A very important, newly discovered use of anthracite silt is as a filter in place of sand. The angular grains of anthracite have many advantages over the rounded grains of sand for this purpose, and are coming into increased favor in the filtering of bacteria and mud and fibrous deposits from swimming pools and sewage water. This form of silt is known as anthrafilt.

Silt is being constantly drawn off as the coal passes through the breaker. It is conveyed to a special building for cleaning and sorting. This building is full of tables that jig and shake with some of the hysteria of the breaker itself. They are called concentrating tables, and onto them is washed the silt that is clogged with the fine slate and dust of the mine. In the mo-

tion of the tables, the impurities remain sluggishly behind in slanting grooves, to be gradually drawn off on one side, while the buoyant anthracite runs gleefully off on the other.

From here the silt is treated to a sky ride on an elevated conveyor. This is called an A frame, because it resembles a gigantic capital A. As the steel flights, about two feet apart on an endless chain, reach the top, the silt they carry is automatically thrown off to the hill of silt below, where it is stored, and the empty plates return on their chain to the ground, there to scoop up another load.

Very fine silt having no commercial value can be used to advantage in flushing abandoned mining chambers. For this purpose it is mixed with water and, by means of boreholes, is flushed into the mine workings. There the water runs off while the silt remains and hardens, making a fine support for the surface that might otherwise cave in. The silt becomes so hard under the pressure of the roof that it can be blasted out like solid coal.

Chapter XII

PERSONNEL

AN ARMY of workers and officials assist and direct the miner in his work and prepare, advertise, and market the coal.

For the safe and profitable conduct of underground operations there are many supervising officials. There is the colliery superintendent, who is directly responsible for both the inside and outside work of the mine. His main duty is to see that the mine operates safely and efficiently. He sees that the plans of the engineering departments are put into effect and hears and tries to settle the complaints of the workers.

There are outside foremen, mine foremen, section foremen, fire bosses, driver bosses, barn bosses, and track and maintenance foremen. Each has his responsibilities both as to the operation of his department and the care of the men under his supervision.

There are drivers and runners for the mule-drawn

cars, motor runners for the electric locomotives, and trackmen to lay new roads and keep the tracks already laid in good repair.

Also there are pumpmen for the pumps, timbermen for the props, consideration miners, company miners, company miners' laborers, and headmen and footmen. A headman gives the signal from the top of the shaft for lowering the cars. The footman gives the hoisting signal. Hoisting engineers have the extremely responsible job of hoisting the carriages in the shaft and the cars in the slopes.

Bratticemen construct the screens used in ventilating the mine. Safety men inspect the work of the miner, instruct him in safety measures, and see that their instructions are carried out. A careless miner is not only a danger to himself, but also to everyone else underground, and anyone who persists in thoughtless, careless habits is eventually dismissed.

In charge of all surface activities is the outside foreman, who supervises the operation of the breaker, the unloading of supplies from railroad cars and trucks, and the loading of supplies into mine cars for transportation to the underground. He also handles the storage of timber supplies, and takes care of any broken or caved-in surface that might permit the en-

try of quantities of water into the mine. He constructs flumes to hold back and carry away any excess water, and is in charge of many gangs of men.

The breaker foreman is responsible for the operation of the breaker, aided by the breaker attendants and mechanics. Engineers operate the steam and electric locomotives that transport the mine cars to and from the various mine openings.

In the offices of a mining company are scores of clerks, accountants, salesmen, and advertising men. There is a legal department, too, each company retaining the full time services of at least one lawyer.

Last, but far from least, are the engineering departments, consisting of electrical, mechanical, and mining engineers. The electrical and mechanical engineering organizations accept the responsibility for the equipment of the mine, and the production of steam and electrical power. They are equipped to repair an electric switch or build a million dollar plant with equal ease.

On the mining engineering department rests the responsibility for planning the work of the mine. The engineers survey the coal fields, make maps, work out plans for the mining of the beds, and concern themselves especially with the relationship of the surface to the underground.

They bore holes in the ground with long, hollow drills to note the nature of the underlying strata, to find out how thick the coal is, in how many beds and how far apart.

They make plans for the most advantageous and safe mining of the coal, planning often five years into the future. They plot the location of the shafts and slopes, with such accuracy that a slope driven on one side of a mountain will meet within a few inches a shaft sunk on the other.

They direct the fighting of mine fires, which sometimes rage for years in the workings of a mine. A peculiar thing about these fires is that it isn't the coal that burns underground, as might be supposed. It is the timbers and then the rock. Anthracite in its solid state cannot be fired. The rock above and beneath the beds, being porous and thus providing minute recepticles for gas, burns steadily, and such a fire is very difficult to extinguish.

The usual method is to block off the burning section and let the fire gradually die from lack of air. Fires can sometimes be put out by hose and water, but the work is very dangerous. The men who fight the fires are in constant danger from explosions of ignited gas,

caving-in of burning territory, and suffocation because of the blocking of air circulation.

A mine fire that had been burning since 1875 was recently conquered by the stripping of the mine. Steam shovels scooped up the surface layer of burning rock while streams of water were played on each shovelful as it was dug up. Steam rose from the red hot rock, but before it was thrown aside, the fire was out on that particular shovelful. When all the rock was removed, the coal was taken up, cool and untarnished by the fire. Anthracite thoughtfully saves its tremendous heat-giving power for the furnaces of the world.

A mining engineer's maps are like X-ray pictures. They enable him to see beneath the surface and know at all times exactly what is going on below. His is the responsibility for protecting surface property, of planning the mining so skillfully that if the surface under buildings is to be caved, it is done so well that the settling is accomplished gradually, and with a minimum of damage to the property, in most cases none at all. Certain institutions own the coal beneath their properties, and the mining engineer so plans the work that this coal is left untouched.

It is a credit to the anthracite industry that visitors to Scranton and its neighboring cities are sometimes

disappointed to find no trace of mining operations other than the presence of the breakers and refuse piles. Yawning craters and leaning buildings are seldom seen. Concrete highways and gleaming railroad tracks enter a region of uncommon beauty. The air is clear and sparkling, the mountains shelter crystal lakes and streams, and woods of evergreen and laurel. The streets are lined with ancient trees, and broad lawns lead up to stately homes.

Other industries rub elbows with the mines. Scranton's silk and lace mills are among the largest in the country. The world's largest correspondence school is here. Downtown buildings rise to the skies in security and beauty, while underneath run miles and miles of tunnels, so cleverly plotted that the blasting and the mining disturb the surface not at all. People of these cities rarely realize that they are living on the mines. Scranton and its sister cities in the heart of the anthracite region stand securely and proudly on their pillars of coal.

The coal that has been taken out from beneath their streets and enclosing hills would be enough to completely cover the island of Manhattan to a depth of one hundred and forty feet. On top of this would go the seventy feet of slate that has come out with the coal.

The railroad cars of anthracite that have left these fields would make a train of cars long enough to go around the world twenty-seven times.

But tremendous as the amount is, it is but a fraction of what is left. There are extensive beds of anthracite that have not been touched, and there is enough coal left in the fields now being mined to provide superlative heat and power for the world's work for another hundred years.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